TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Human Robotic Interaction

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14. ABSTRACT
Mission Integrate, Explore, and Develop Robotics, Network and Control Components with a Focus on Customer Driven Requirements to Provide Full System Solutions to the War Fighter

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Mission

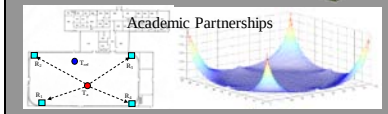
Integrate, Explore, and Develop Robotics, Network and Control Components with a Focus on Customer Driven Requirements to Provide Full System Solutions to the War Fighter

Technology Components









Integration

Demonstrators

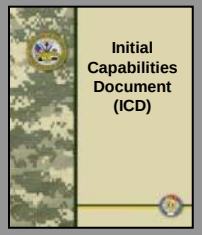

SME Defined Scenarios

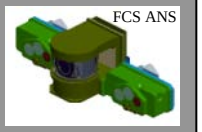
Military Relevant Test & Experimentation



Tech Transfer

Transition and Requirements Development

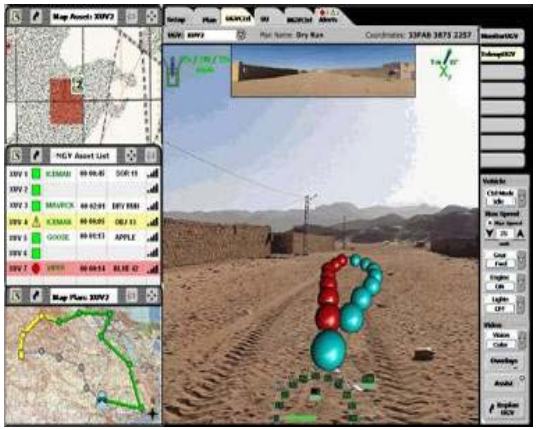



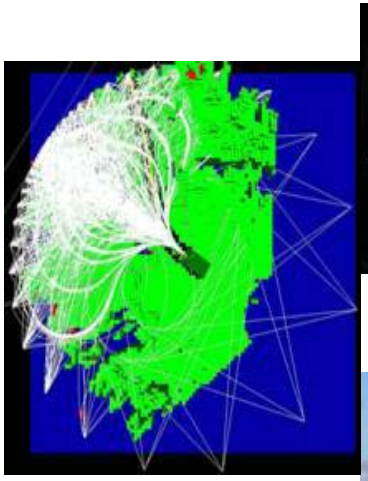


Integration Technology Development Lessons Learned to Enable Early Technology Insertion

Human Robotic Interaction Research Areas

Tactical behaviors





UGV – Soldier Interfaces

High-Speed Tele-operation

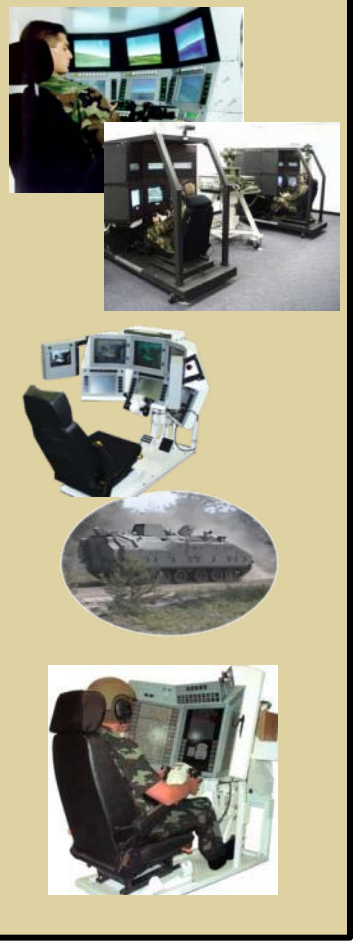
Autonomous Control

Human – Robot Interface

Crewstation Advancements

PAST

- Workload reduction
- Embedded crewstation



PRESENT

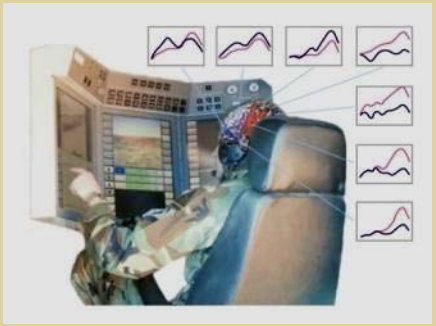
- Robotic control (mounted, dismounted)
- Driving aids (Soldier assist)
- Scalable, portable Interface

Embedded Simulation

Dismounted Controller

FUTURE

- Soldier monitoring and task assist
- Intelligent agents
- 360 degree situational awareness



Robotics Collaboration (RC)

Purpose: Develop the tools, techniques, & autonomy to maximize mounted and dismounted control of ground and air unmanned systems and optimize Soldier-robot and robot-robot ground and air teams

Scalable Interface:

– Increased scalability, portability and tailorability of Soldier Machine Interface—reduces training burden

– Control multiple unmanned system– one device can support unique robots from different vendors

Driving Aids:

– Enables Soldiers to take actions of a semi-auto vehicle while staying in obstacle avoidance

– Increased mission OPTEMPO, reduced intervention times

– Provides Situational Awareness of unmanned system

– Increased insight in unmanned system planning activities

Improved Mobility and Operational Performance through Autonomous Technologies (IMOPAT) ATO

360/90 Day/Night
Near-field Sensor Coverage

Soldier Monitoring
& State Classification

Advanced
Crew Stations

Enhance, Integrate and Demonstrate 360/90 LSA/Assisted Mobility/Human Dimension to Maximize Indirect Vision 360/90 LSA and Mobility Capabilities (Secure Mobility)

- **Focus on closed-hatch operations, indirect vision**
- **360/90 degree local area awareness**
- **Improved mobility via non-LADAR and LADAR based solutions**
- **Improved assessment and integration of operator performance in real-time**
- **Increase situational awareness for all crew members**

Manned Vehicle Robotic Control

Robotics Collaboration ATO Capstone

Improved Mobility and Operational Performance through Autonomous Technologies (IMOPAT) ATO

360/90 Day/Night
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Following, Awareness, Safe-Ops, and Tracking through Intelligent Ground Systems (fastIGS)

Purpose:
Integrate, enhance, and demonstrate a 360° Spatial Awareness System using Ultra Wide Band for Dismounted Following and Mounted Autonomous Tactical Behaviors.

Payoff:
Drastically minimizes the amount of soldier intervention required to take unmanned systems along in dismounted operations. Provides 360° Spatial Awareness for all assets in the system (manned and unmanned).

Goals & Objectives

360/90 Day/Night
Near-field Sensor Coverage

Advanced
Crew Stations

Integration Platform
with Electro-Optic
Indirect Vision
System

Soldier Monitoring
& State Classification

Goals:

To develop indirect vision / drive by wire systems that provide electro-optic indirect vision based local situational awareness and mobility capabilities at or above the performance levels of direct vision mechanical drive systems, along with enhancing high definition cognition technologies to dynamically manage workload to increase the operational performance of future platforms.

Objective:

Through the TARDEC led IMOPAT ATO that contains CERDEC-NVESD, ARL-HRED, and NSRDEC as joint partners, the ATO will mature visual sensor suites, human integration, and assisted mobility technologies in three phases of evolution:

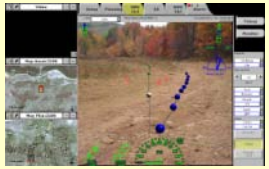
- Baseline: Establish initial indirect vision driving (IVD) and 360 degree local situational awareness (LSA) capabilities.
- Enhanced: Increase IVD and LSA capabilities.
- Advanced: Integrated state of the art IVD and LSA system providing a “secure mobility capability”.

Planned Schedule

Activity	FY09	FY10	FY11	FY12
GCV Milestones	RFP Release	SSEB / Award	Selected Contractors Design/Development	Competitive Subsytem Testing / Award
Prime Contract Awarded				
August 2010 Demonstrator (360 Vision SA)				
Integrate 360 SA Sensors				
Integrate Commander WMI Software				
Upgrade Drive By Wire				
Upgrade Digital Video Architecture				
360 LSA Demo (Ft. Hood)				
Enhanced Experiment - Final 360 Vision SA and DVA				
Integrate Final 360 LSA Sensors				
Integrate Final DVA				
Integrate Final (GCV Version) Commander & Driver WMI SW				
Integrate HD-Cog Sensors*, DVR (if available)				
Conduct Experiment (Ft. Hood*)				
Capstone Engineering Evaluation Test (EET)				
Integrate Upgraded: WMI SW, 360 SA Sensors, HD-Cog Sensors/Algorithms, DVR				
Integrate Additional LSA Sensors (Acoustic Sensors, Enhanced CROWS, Commander's Gimbal, Virtual Pointer), OTM/MTI, OA, Dismount/Squad Leader Display				
Conduct EET (Ft. Hood**)				
Capstone (Ft. Hood*)				

Partnerships

Crewstation & Mobility



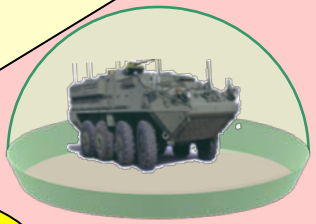
System Integration & Test

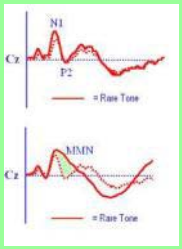
Adaptive Displays & Dynamic Re-Tasking

Warfighter Machine Interface

TARDEC

Assisted Mobility





Human Integration

Human Performance Research & Testing

IMOPAT (TARDEC Led)

Enhanced Imaging for Driving & Threat Detection

Sensors

ARL - HRED

CERDEC - NVESD

Mounted Soldier Real-time Monitoring, Assessment & Cueing

Motion Based Threat & Gunfire Detection, Localization & Recording

360° DVR

Human Dimension

Dismount Soldier Monitoring

NSRDEC

Dismount Soldier Local Situation Awareness

Dismounts

Military Relevance

- Intelligent Ground Systems ATO Operational Concept Development
  - Op Orders: Secure building in urban environment utilizing manned and unmanned assets
  - Slide Show Description
  - Animation Video
    - Improved Mobility and Operational Performance through Autonomous Technologies (IMOPAT) ATO Technologies:
      - Electro-optic based indirect vision driving and local situational awareness
        - » Crewstations & warfighter machine interfaces
        - » Mobility aids
        - » Crew and squad local situational awareness
        - » Aided target and threat cueing
        - » Assisted slew to cue threat interrogation and response
        - » Digital video recording of 360 degree environment
        - » Unmanned vehicle situational awareness, control and handoff
        - » High Definition Cognition Elements – Not Illustrated
    - Safe Operations of Unmanned Systems for Reconnaissance in Complex Environments (SOURCE) ATO Technologies
      - Safe operation of unmanned ground vehicles in a complex urban environment
      - Small unmanned ground vehicle based building mapping
  - Show Video: IGS ATO Operational Concept

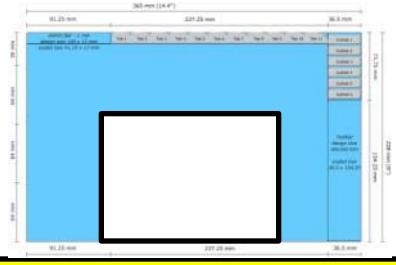
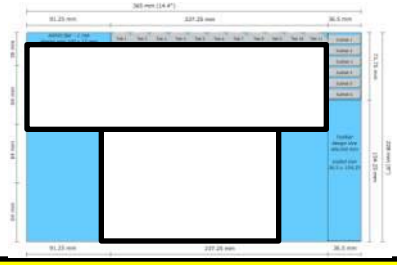
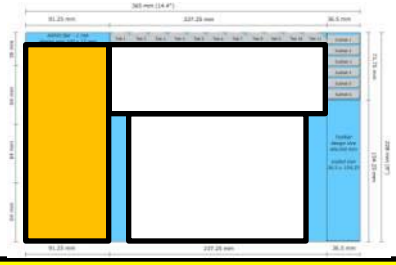
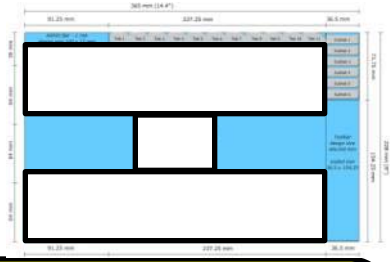
Surrogate Common Crew Station (SCCS)

Key Features

- Adjustable seats, pedals, hand controllers, and display to fit a wide range of the population
- Four 17” display that meet FCS’s requirements. Three displays for the driver (left side), one display for the commander (right side).
- 4 Warfighter Machine Interface (WMI) PCs (one for each display).
- Four Video Processing Unit (VPU) (one VPU for each display). The VPU’s are capable of inputting four video inputs. Then overlaying the WMI and outputting the merged image to the display.

Figure: SCCS System Integration Lab (SIL). There is an identical SCCS in TARDEC’s Crew Automation Testbed (CAT). The CAT is a M1126 ICV.

Commander Local Situational Awareness

	Condition 1	Condition 2	Condition 3	Condition 4
Design				
Color Sensor View				

C4 design modification: crop banners, expand sensor view

Color view selected for experiment

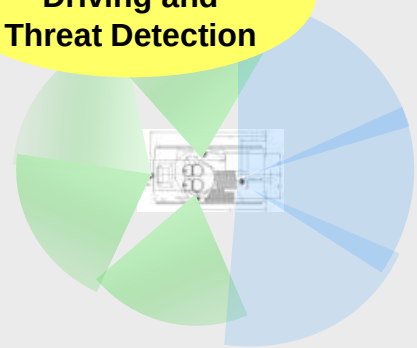
Use Case Development

- These reference documents were used to create IMOPAT Use Cases:
  - **IMOPAT Operational Concept document** – primary reference
  - IMOPAT ATO Charts
  - Role to (vehicle) position matrix
  - MGV Role White Paper
  - User Interface (UI) Spec List
  - FCS Target Audience Description
  - ARL FCS IMPRINT models
  - MGV UI Book
- After the reference materials were collected and studied, the IMOPAT Function/Task List and Roles were derived
- The Use Cases were created leveraging the function/task list and roles. A format was followed & change management was performed for each Use Case.
- 7 Use Case Types:
  - Mission Planning and Execution
  - Control Manned Vehicle
  - Command Vehicle
  - Local SA
  - Control Unmanned Vehicle
  - Communications
  - Enemy Engagement**

Urban Sensor Suite

Closed Hatch Hemispherical Vision Integrated with Threat Cueing, Video Capture, and Slew to Cue Interrogation

Improved Driving and Threat Detection



High Frontal Resolution Closed Hatch 360 Vision

Sensors, System Processor, Controls and Displays

Target Handoff via Virtual Pointer

Virtual Pointer in Weapon Sight for target handoff between SUGV and Dismounts

SUGV with SWIR Zoom

Threat Cueing & Image Capture

Acoustic Gunfire Detection

Improved SA and operator workload reduction

360° DVR with tagging

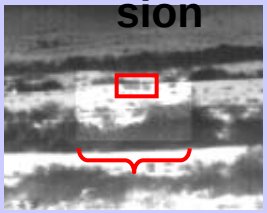
Motion Based Cueing for Pop Up/Close-In Target Detection

Slew to Cue via High Resolution Imager (e.g. Enhanced RWS/CROWS)

Rapid Slew to Cue from 360 Vision to High Resolution Imager

WFOV Supports OTM Operations

"Green" Laser for Non-Lethal Suppression



WFOV Inset into 360° Vision With Touch Screen GUI

Commander's Gimbal w/Non-Lethal Suppression

Separate Stabilized Gimbal (automatic & manual modes)

Enabler for Improved Survivability and Lethality

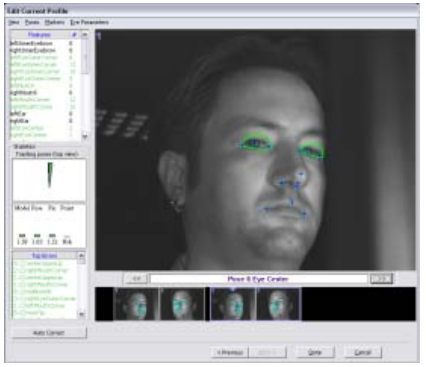
- Indirect-vision-based intelligent manned and unmanned vehicle mobility

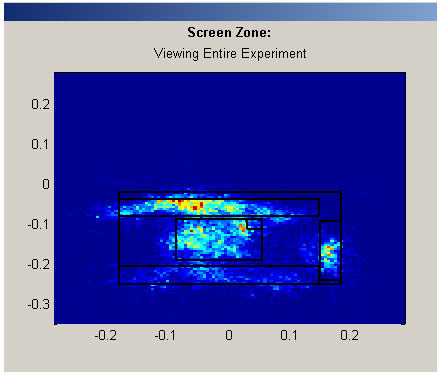
- Mode-switching for driving

- Soldier-machine interface design to enable local area security

- Cueing for crew task management for local area security and vehicle mobility

- Soldier monitoring/state-based advanced crewstation design for enhanced Soldier performance.



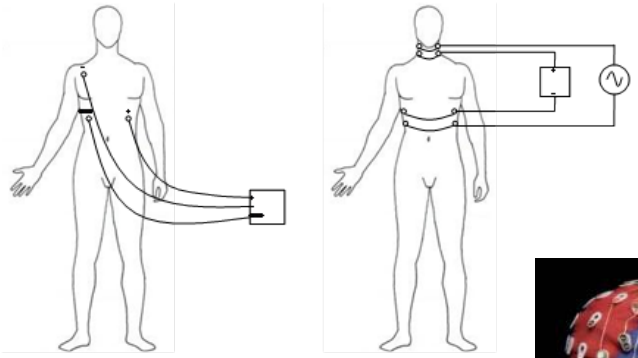


HD-Cog Objective

To integrate "high definition" assessments of Soldier cognitive function into neuroergonomically-designed controls and displays

Focus on:

- **Visual scanning**
- **Platform control**
- **Spatial cognition**
- **Decision making**



Develop Neuroergonomically-designed Guidelines for:

- **Sensor & DAQ Infrastructure**
- **Signal Processing & Cognitive Assessment**
- **Real-time Techniques to Enhance Soldier-System Performance**

Predictive Model of Spatial Cognition

Operationally-relevant Cognitive Metrics

Dismount Local Situational Awareness

Problem: Dismounting infantry “ride blind” to the state of the battlespace, unable to update their dynamic location to prepare for efficient operations.

Purpose: Perform human subjects research and provide data to guide down-selection of form factors and organizational principles to enhance Soldier rapid development of spatial awareness immediately prior to dismount.

Results/Products: Cognitive task analysis and research-based principles for form factor selection and visualizations to promote dismount SA.

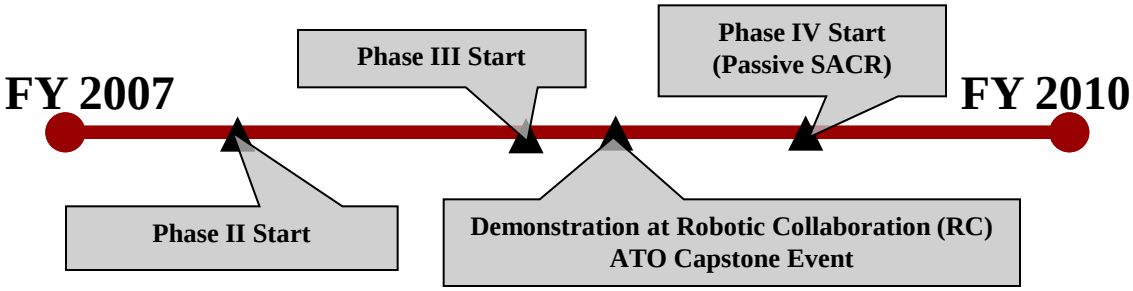
Payoffs: Improved dismount orientation and navigation performance, improved survivability and enhanced mission effectiveness.

Enhance Soldier situational awareness by porting crew station data streams to dismounting Infantry.

Facilitate efficient and accurate orientation and movement to objectives, and mission success.

Situational Awareness via Colorized Ranging (SACR) (NREC)

- Combines synchronized range data and image data to create a 3D virtual model of the world in real-time.
- Allows the operator to select an arbitrary “third-person” viewpoint such as bird’s eye, over the shoulder, etc.
- Compensates for latency using operator input and motion prediction to update the virtual model on-the-fly.
- Maintains a database of virtual “breadcrumbs” in the form of a path that allows an operator to distinguish between previously visited and unexplored areas.
- Current efforts are exploring usage of a passive stereo vision system instead of a laser range finder for geometrical information.



Questions















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